International Journal of Scientific Research and Engineering Development- Volume 9 Issue 4, July – August 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

AI Driven Immigration Decision Support System

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Abstract:

The rapid increase in the number of global visa applications has added a lot of complexities to immigration decision making, which made the traditional manual process both lengthy and inconsistent. In order to overcome such difficulties, the present paper proposes an AI-enabled Visa Approval Prediction System that utilizes machine learning together with MLOps to facilitate the process of making correct, efficient and scalable immigration decisions. The proposed framework involves the analysis of historical visa application data through the consideration of such attributes of applicants as education, experience, prevailing wage, company, employment region and job details. The selection of machine learning algorithm that provides the best possible prediction results out of several supervised machine learning algorithms is carried out. The whole process of machine learning is fully automated using an MLOps pipeline consisting of the stages of data ingestion, preprocessing, training, validation, deployment and monitoring. The proposed framework relies on Docker for containerization, GitHub Actions for CI/CD pipeline automation, AWS for the scalable deployment and MongoDB for the management of the data efficiently. Continuous monitoring and model versioning help to keep the performance of the model consistent.

Keywords - **Machine Learning, Artificial Intelligence, Visa Approval Prediction, Immigration Decision Support System, MLOps, Docker, AWS, Predictive Analytics.**

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I. INTRODUCTION

The rapid increase in global migration for employment, higher education, and business opportunities has significantly raised the number of visa applications processed by immigration authorities. Evaluating these applications requires careful analysis of multiple factors, including educational qualifications, work experience, employer details, salary information, and compliance with immigration regulations. As application volumes continue to grow, traditional manual evaluation methods have become increasingly time-consuming, resource-intensive, and susceptible to inconsistencies in decision-making.

These challenges highlight the need for intelligent technologies that can support immigration officers in making faster, more accurate, and consistent decisions.

Machine Learning (ML) has emerged as an effective solution for analysing large-scale datasets and identifying meaningful patterns that may not be easily recognized through manual assessment. By learning from historical visa application records, ML models can estimate the likelihood of visa approval based on various applicant attributes. Such predictive systems not only improve processing efficiency but also assist authorities in making evidence-based decisions while reducing manual effort and operational delays.

However, developing an accurate machine learning model alone is not sufficient for real-world deployment. Production environments require continuous monitoring, automated model updates, and reliable deployment mechanisms to maintain consistent performance as new data becomes available. To address these challenges, this work integrates MLOps practices with machine learning, enabling automated data preprocessing, model training, validation, deployment, and monitoring. The proposed AI-Driven Immigration Decision Support System provides a scalable and practical framework that enhances transparency, improves decision consistency, and supports immigration authorities through intelligent, data-driven visa approval prediction.

Furthermore, the proposed framework evaluates multiple supervised machine learning algorithms to determine the model that provides the most reliable prediction performance for visa approval. The learning process involves comprehensive data preprocessing, feature engineering, model training, and performance evaluation using standard classification metrics such as accuracy, precision, recall, and F1-score. By analysing relationships among various applicant attributes, the system identifies patterns that contribute to visa approval decisions while maintaining consistency across large datasets. This data-driven approach minimizes manual intervention and enables immigration authorities to focus on complex cases that require expert review, thereby improving both operational efficiency and decision quality.

II. MATERIALS AND METHODS

The proposed AI-Driven Immigration Decision Support System has been developed to provide an intelligent and reliable solution for predicting visa approval outcomes by integrating Machine Learning (ML) with Machine Learning Operations (MLOps). The primary objective of this system is to assist immigration authorities in making faster, more consistent, and data-driven decisions while reducing the dependency on manual evaluation. The methodology adopted in this research follows a systematic workflow that begins with data collection and preprocessing, continues through model development and evaluation, and concludes with cloud deployment and continuous monitoring using modern MLOps practices.

The study utilizes a historical visa application dataset that contains records of previously processed visa applications. Each record consists of several important attributes that influence visa approval decisions, such as the applicant's educational qualifications, work experience, prevailing wage, employer information, job category, employment location, and other relevant details. Since the collected dataset contains both numerical and categorical information, it requires extensive preprocessing before it can be used for machine learning. The preprocessing stage involves cleaning the data by removing duplicate entries, handling missing values, correcting inconsistencies, and transforming categorical variables into numerical representations using appropriate encoding techniques. In addition, numerical attributes are standardized whenever necessary to ensure that all features contribute effectively during model training. These preprocessing steps improve the quality of the dataset and enable the learning algorithms to generate more accurate and reliable predictions.

Once the dataset is prepared, it is divided into training and testing subsets to evaluate the performance of different machine learning models. The training dataset is used to enable the algorithms to learn relationships between applicant characteristics and historical visa approval decisions, while the testing dataset is utilized to assess the predictive capability of the trained models on previously unseen records. Several supervised machine learning algorithms are implemented and compared to identify the model that delivers the highest prediction accuracy and generalization performance. During the training process, the algorithms learn complex patterns within the historical data and establish relationships among multiple applicant attributes that contribute to visa approval or rejection. The trained models are further optimized using suitable hyperparameter tuning techniques to improve prediction performance while minimizing overfitting.

The proposed AI-Driven Immigration Decision Support System is evaluated using standard classification metrics such as accuracy, precision, recall, F1-score, and confusion matrix analysis to ensure reliable and consistent prediction performance. After identifying the most effective machine learning model, the system is deployed through an end-to-end MLOps pipeline that automates model packaging, deployment, monitoring, and maintenance. Technologies such as Docker, GitHub Actions, AWS, and MongoDB are integrated to provide a scalable, secure, and production-ready environment for real-time visa approval prediction. Continuous monitoring and automated retraining enable the model to adapt to changing immigration trends and maintain its prediction accuracy over time. Overall, the proposed methodology combines machine learning with modern MLOps practices to deliver an efficient, reliable, and intelligent decision support system that assists immigration authorities in making faster, transparent, and data-driven visa approval decisions.

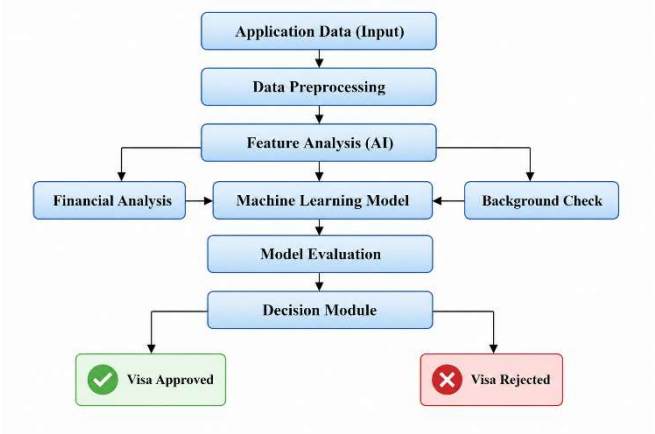

fig. 1. Proposed System

III. LITERATURE SURVEY

Several researchers have applied Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), and Machine Learning Operations (MLOps) to improve visa approval prediction and immigration decision-making. These studies mainly focus on developing accurate prediction models, identifying important applicant attributes, and deploying machine learning systems in scalable production environments. The following literature survey summarizes the major contributions of existing research.

1. G. Madhupriya, V. Vineesha, S. Sarumathi, and M. Raasheedaa Shameem (2024) [1] proposed an Automated H1B Visa Application Processing System (AHAPS) using a Deep Neural Network (DNN) for visa approval prediction. The model also identified key factors influencing visa rejection through feature extraction. Using the Kaggle H1B dataset, the system achieved 98.2% accuracy. However, the study mainly focused on prediction accuracy without considering deployment or continuous model monitoring.

2. Anay Dombe et al. [2] compared Logistic Regression, Random Forest, Gaussian Naïve Bayes, and Neural Network algorithms for H1B visa prediction. Their results showed that Logistic Regression and Neural Networks provided better classification performance than the remaining models. Although the study improved prediction accuracy, it mainly focused on model development and did not address deployment or lifecycle management.

3. Pooja Thakur et al. [3] proposed a multi-level ensemble learning framework by combining Decision Tree, Support Vector Machine, Random Forest, Neural Network, Naïve Bayes, and C5.0 classifiers. The ensemble model achieved approximately 95.4% prediction accuracy, outperforming individual classifiers. However, the framework did not include cloud deployment, automated monitoring, or model retraining.

4. Beliz Gunal et al. [4] evaluated Naïve Bayes, Logistic Regression, Support Vector Machine, and Artificial Neural Networks for visa approval prediction. Their study identified prevailing wage and employer history as important decision factors, while Artificial Neural Networks produced the best performance. The research mainly compared algorithms and did not focus on production deployment.

5. Aditya Umesh, Harsha H. G., Tarunkumar K., Sanchit Sharma, and Pooja P. (2025) [5] proposed an end-to-end MLOps framework for US visa approval prediction. The system integrated machine learning models with Docker, AWS, GitHub Actions, and CI/CD pipelines to automate model training, deployment, monitoring, and retraining. This approach improved scalability, reproducibility, and operational efficiency.

6. Stephen John Warnett and Uwe Zdun (2024) [6] investigated the understandability of MLOps architectures using UML-based system representations. Their research demonstrated that structured architectural models improve readability, maintainability, and collaboration when developing complex machine learning applications. The study provides useful guidelines for designing scalable MLOps-based systems.

7. Mikko Raatikainen, Charalampos Souris, Jukka Remes, and Vlad Stirbu (2025) [7] proposed a Machine Learning Lineage Framework to improve transparency and trustworthiness in MLOps pipelines. Their framework maintains traceability of datasets, model versions, training history, and deployment records.

IV. EXPECTED CONCLUSION

A. Prediction Performance:

The proposed AI-Driven Immigration Decision Support System is expected to accurately predict visa approval outcomes by utilizing supervised machine learning algorithms trained on historical immigration data. Through effective data preprocessing, feature engineering, and model optimization, the system is anticipated to identify complex relationships between applicant attributes and visa decisions. The evaluation using metrics such as accuracy, precision, recall, and F1-score is expected to demonstrate reliable prediction performance, enabling faster and more consistent immigration decision-making compared to traditional manual evaluation methods

B. Automated Decision Support:

The proposed system is expected to provide an intelligent decision support mechanism that assists immigration authorities in evaluating visa applications more efficiently. Instead of replacing human decision-makers, the framework offers predictive recommendations based on applicant information, helping officials reduce processing time and improve consistency in decision-making. The integration of explainable machine learning techniques further enhances transparency by enabling users to understand the factors influencing visa approval predictions

C. Scalable MLOps Deployment:

The proposed framework incorporates an end-to-end MLOps pipeline using Docker, GitHub Actions, AWS cloud services, and MongoDB to automate model deployment, monitoring, and maintenance. This automated workflow is expected to improve scalability, reproducibility, and operational efficiency while supporting continuous integration and deployment (CI/CD). Furthermore, continuous monitoring and periodic model retraining enable the system to adapt to evolving immigration policies and changing applicant trends, ensuring long-term prediction reliability.

D. Final Assessment:

Overall, the proposed AI-Driven Immigration Decision Support System is expected to provide a reliable, scalable, and production-ready solution for intelligent visa approval prediction. By combining robust machine learning models with modern MLOps practices, the framework offers an efficient approach for supporting transparent, consistent, and data-driven immigration decisions. The proposed methodology also provides opportunities for future enhancements, including the integration of explainable AI, real-time visa application analysis, multi-country immigration policy support, and advanced deep learning techniques to further improve prediction accuracy and system adaptability.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the Department of Information Science and Engineering, Don Bosco Institute of Technology, Bengaluru, for providing the necessary guidance, facilities, and continuous support throughout this research. We are especially thankful to our project guide and faculty members for their valuable suggestions and encouragement during the development of this work. We also acknowledge the support of the open-source community and the providers of the US Visa/H1B Visa application dataset, as well as the developers of Python, Scikit-learn, Docker, GitHub Actions, MongoDB, and Amazon Web Services (AWS), whose technologies greatly contributed to the successful implementation of the proposed AI-Driven Immigration Decision Support System.

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